Design and implementation of intelligent travel recommendation system based on internet of things

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ABSTRACT. *Along with the rapid development of Internet of Things, the informationization process of travel industry has been speeded up. In the face of the challenge of big data, the recommendation of intelligent travel service has been highly praised. Under the environment of Internet of Things, this study deals with the travel data based on Hadoop, then sets up the relational data tool and distributed cluster, and configures it to ensure that the program can operate well on the cluster. The operation mechanism and programming method of MapReduce are adopted as the core algorithm. At the same time, the classical FP-Growth data mining algorithm is parallelized, and then the recommendation travel information service is realized. The recommendation system is more integrated and the provided service is more comprehensive and personalized, which makes the travel service platform more humanized and experience better for users.*

RÉESUMÉ. *Le développement rapide de l'internet des objets a accéléré le processus d'informatisation touristique. Face aux défis du Big Data, les recommandations du tourime intellectuel sont très appréciées. Basé sur Hadoop, cet article conçoit le traitement des données touristiques dans l'environnment de l'internet des objets, puis construit des outils de données relationnels et des clusters distribués, et les configure pour que le programme puisse mieux fonctionner sur le cluster. Le mécanisme d'exécution et la méthode de programmation de MapReduce sont adoptés comme algorithme principal et l'algorithme classique de data mining de FP-Growth est parallélisé afin de réaliser le service d'informations touristiques recommandé. La conception du système de recommandation est plus intégrée et les services fournis sont plus complets et personnalisés, ce qui rend la plate-forme de services de voyage plus conviviale et améliore l'expérience utilisateur.*

KEYWORDS: *internet of things, intelligent travel, recommendation platform, hadoop.*

MOTS-CLÉS: *internet des objets, tourime intellectuel, plate-forme de recommandation, hadoop.*

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1. Introduction

At present, “intelligent travel” is the main task and hot research problem of Chinese travel industry information construction. Travel service recommendation system, as the embodiment of intelligent travel, becomes a popular marketing strategy in travel industry (Chen *et al*., 2016; Yao *et al*., 2016; Cai *et al*., 2014). As an effective method to solve the information load, the recommendation system has good practicability and potential commercial value, which can not only find the appropriate or potential information for users through the recommendation technology, but bring a better experience to users. Therefore, it has been widely and deeply studied by many scholars. Chen et al., according to the preference of mobile users, spontaneously provide personalized services for tourists and help users find the right hotels and scenic spots. Based on the accurate analysis of big data, the travel e-commerce recommendation system developed by Yan pushes the recommendation result to each marketing link of travel e-commerce in the form of service display, greatly increasing the conversion rate of product purchasing (Gao *et al*., 2017; Jayaraman *et al*., 2016; Choi *et al*., 2015). Although travel information service is constantly developing and travel service providers are pursuing change in platform and marketing mode, the introduction of high and new technology is far from enough. There are few Internet operators who can provide relevant services. In addition, the recommendation effect is not good, such as lack of corresponding mechanism, single recommendation, lack of multi-objective recommendation, poor experience, and lack of humanization.

Under the background of big data, this study will deal with the personalized service recommendation of intelligent travel based on Internet of Things. By improving the recommendation technology, the travel service platform will become more humanized so that users will get better experience.

2. HADOOP cloud computing platform

At present, HADOOP is an optimal cloud computing platform for processing big data. HDFS and MapReduce are an important part of it (Veltri *et al*., 2013; Elbaz and Haddoud, 2017; Ahdiati and Pratiwi, 2014. Through the application of distributed computing, MapReduce can quickly process mass data. HDFS is safe and stable and can store mass data (Jamal, 2004; Baker and Coulter, 2007). Hadoop is a top-level project, under which there are many subprojects, such as hbase and hive, which can operate and store mass data. The following figure shows the contents of all the subprojects:

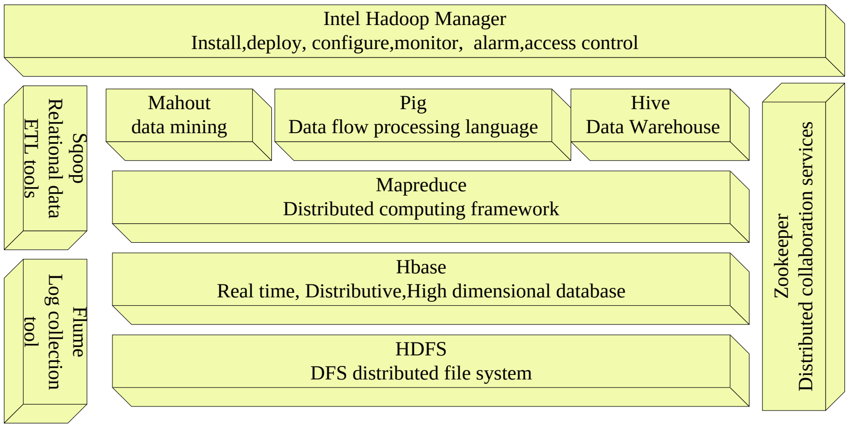

Figure 1. Subprojects under the Hadoop top-level project

2.1. Distributed file system HDFS

At present, HDFS is one of the most widely used distributed file systems. It is relatively stable, safe and fault-tolerant (Sharpley, 2001; Ge *et al*., 2004; Christensen *et al*., 2016). Thus, it is widely used in the storage of mass data. The main reason for choosing HDFS is that the cost is relatively low, so it can be deployed on a cheap hard disk, can support high throughput capacity and is suitable for mass data.

2.2. HADOOP calculation model --- MAPREDUCE

MapReduce, a software framework that can operate on a cluster composed of commercial machines, can rely on reliable fault-tolerant methods to process mass data in parallel. It is not only fast, but relatively efficient (Lin, 2009; Cheng *et al*., 2015). Its programming principle can be divided into two stages, namely, reduce and map, respectively corresponding to the two function expressions of Reduce () and Map (). The set of key / value pairs is taken as input data and forms a corresponding intermediate output result, and is also the input data of the Reduce () function. After the operation, output result can be obtained from the function (Wang *et al*., 2017; Chen *et al*., 2010). The data flow diagram corresponding to MapReduce is as follows:

2.3. Relational data ETL tool SQOOP

Sqoop is a relational data ETL tool that can realize the interaction of relational databases and HDFS data (Neal *et al*., 1999; Kim *et al*., 2011). For example, users can transfer the data in the relational database such as HDFS. Users need to view the database table of MySQL, and then view the data under the HDFS file system, transfer the HDFS data in the relational database MySQL, and then check it in the database.

3. Framework design of travel service recommendation system under the environment of internet of things

On the Hadoop platform, a travel service recommendation system is developed, which can not only solve the problem of storing a large amount of travel data, but also solve the problem of calculation. The system is designed based on B/S architecture. The framework diagram is as follows. The key point of the system is to complete the recommendation algorithm based on cloud computing platform. In summary, the work that the system needs to complete includes four aspects, namely data collection, algorithm, parallelization recommendation algorithm, completion of service recommendation.

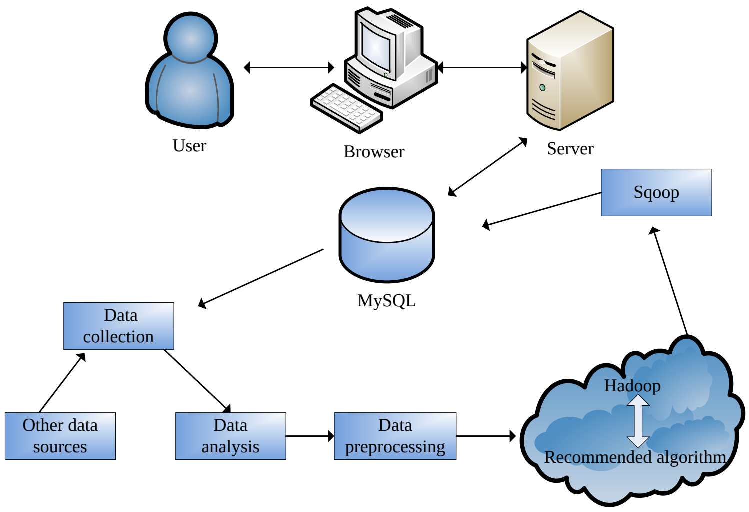

Figure 2. Framework of intelligent travel recommendation system in the internet of things

3.1. Data collection module

The study needs to complete collection of a large amount of data first, and then carries out the experimental work. The data are un-structuralized and structuralized, and most are un-structuralized, so rational classification is needed in the collection of data. Therefore, this study selects LocoySpider as a professional collection tool, and then obtains the data. The software is relatively simple in operation and its collection function is outstanding. The most critical is that it can effectively classify the collected resources. In essence, it belongs to a web crawler program, and the collection software is formed by encapsulating several functions.

3.2. Data analysis module

3.2.1. Statistical analysis of seasonality of travel

The seasonality of travel is embodied as follows. In term of time, that reception amount of tourists is not balanced. Based on the obtained travel information, the seasonality of travel is statistically analyzed. The number of tourists is selected as the index combined with Xi'an to explore the distribution characteristics of inbound tourist, mainly focusing on the following three aspects, namely, time of stay, the change of tourist amount; the change of tourist amount with the change of month; change of the number of tourists and the number of accompanying people. Then the characteristics of tourists, the seasonality intensity index are analyzed.

The formula for calculating the seasonality intensity index is as follows:

$$R = \sqrt{\sum_{i=1}^{12} (x_i - 8.33)^2 / 12} \tag{1}$$

x_i is the proportion of tourist amount in different months of the year. The closer the value is to 0, the more uniform the allocation of demand time is; if it is larger, there is a prominent time change.

3.2.2. Analysis of travel flow based on social network

(1) The scale of travel flow network

In the travel flow network, the network scale refers to the corresponding number of nodes of the travel network. The following formula is the number of all possible relationships of the directed network diagram, and the number of travel nodes is *k*.

$$k \times (k-1) \tag{2}$$

The following formula is the number of possible relationships in an undirected network diagram, and the number of travel nodes is *k*.

$$[k * (k-1)]/2 \tag{3}$$

(2) Density of travel network

It is the ratio of the total number of practical connection to theoretical connection, which can express the degree of closeness of all node connections and be calculated in combination with the following formula.

$$D = (2\sum_{i=1}^{k} d_i(n_i)/(k*(k-1)) \tag{4}$$

Where,

$$d_i(n_i) = \sum_{j=1}^{k} d_i(n_i, n_j) \tag{5}$$

k is the number of nodes, the value of D is between 0-1. If it is 0, there is no correlation between them; if it is 1, it corresponds to the closely correlated scenic spot in the ideal state.

(3) Centrality of travel network

In social network analysis, centrality is a major focus and is used to quantify the central positions of the actors or the rights they have. In the travel flow network, it embodies the ability of central travel nodes to radiate and gather other nodes.

Table 1. Central analysis public table

	Degree Centralization	Between nesscentrality	Close nesscentrality
Absolute point center	$C_{ADi} = i$	$C_{ABi} = \sum_j^n \sum_k^n b_{jk}(i)$ $j \neq k \neq i(j < k))$	$C_{APi}^{-1} = \sum_{j=1}^{n} d_{ij}$
Standardized centrality		$C_{RBi} = \frac{2C_{ABi}}{(n^2 - 3n + 2)}$	$C_{RPi}^{-1} = \frac{C_{APi}^{-1}}{(n-1)}$
Central potential	$C_{RD} = \frac{\sum_{i=1}^{n}(C_{RD\max} - C_{RDi})}{n-2}$	$C_B = \frac{\sum_{i=1}^{n}(C_{RB\max} - C_{RBi})}{n-1}$	$C_C = \frac{\sum_{i=1}^{n}(C_{RC\max} - C_{RCi})(2n-3)}{(n-2)(n-1)}$

3.3. Parallelization of FP-Growth algorithm

For example, FP-Growth and Apriori are commonly used association rule mining algorithms. This study chooses the former. When the association rule analysis is finished, this algorithm will not lead to the generation of candidate set. In the operation process, the algorithm only makes two accesses to the database, which has the outstanding effect of traversing the data. However, it will also face the problem that when the number of transactions is too large, it will prolong its operation time. The specific reason is as follows: the recursion of FP tree will lead to many operations, and the internal and external storage convert with each other so that the operation encounters blocking. Therefore, the study relies on the application of the cloud computing platform, changes this again, and the realization of MapReduceFP-

Growth strengthens the performance of the algorithm. The following is the corresponding codes:

MapReduceFP-Growth Algorithm pseudocode description (Pseudocode algorithm):

```
MapInput:<null,transactions>
MapProcedure:
ForeachIintransactionsTi
ForeachIiinI
MapOutput:<Ii,I>
ReduceProcedure:
Count=0
Do
Values.hasNext()
Count=count+1
end
```

3.4. Service recommendation module

The data mining engines form this module, taking MapReduceFP-Growth algorithm as the core. Besides the offline algorithm, MVC is applied to the online recommendation service, and the recommendation result is presented combined with the application of the browser.

3.4.1. Recommendation service modeling

As for system modeling, the recommendation service is divided into two parts, including offline part and online part. The offline part generates association rules while the online part recommends the results.

(1) Offline part model design of recommendation service

The key of the offline part is based on the cloud environment to realize the algorithm. It needs to pre-process the prepared data and transform it to the transaction data which can be calculated by the algorithm. When the algorithm is completed, four steps are required, that is, the minimum support degree is set to form the frequent item set, which is filtered by the minimum confidence coefficient, and the association rules are finally generated. The corresponding modeling is as follows:

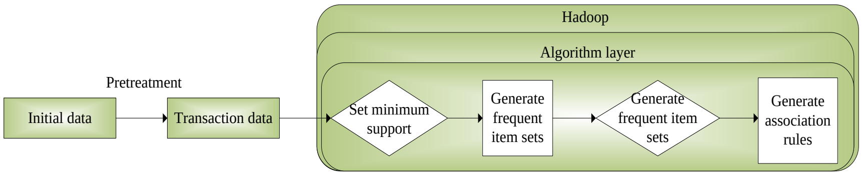

Figure 3. The design model of the offline rule library

(2) On-line part model design

In the classical development mode, the system architecture consists of storage, view and business logic layers. The three layers are dependent on each other. The view layer depends on the business logic layer, which is realized by the idea of low coupling and high cohesion with the storage layer. The system is mainly used for the completion of the recommendation service, and the system recommends personalized and large-scale travel service to users in combination with the situation where users use the system. The specific design is in the following figure:

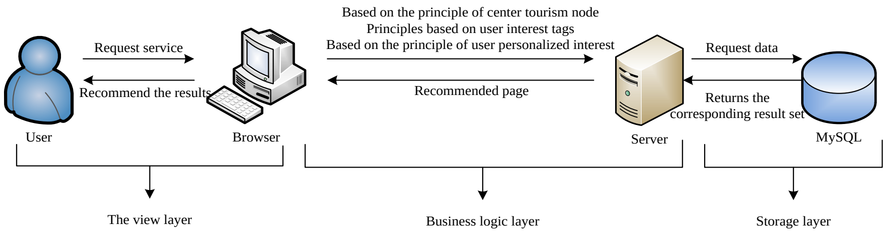

Figure 4. Online part model design

3.4.2. Service recommendation process

The system uses the B-S architecture to access the server resources combined with the browser. When obtaining the recommendation information, the specific flow is as follows. Users should log into the system smoothly, and then match the formed association rule set according to the browsing of the resources and interest record. If the query obtains the corresponding result set, it can be returned from the server, and then the browser can be used to view this.

4. Implementation of intelligent travel recommendation system

4.1. Data collection

4.1.1. Data collection from a travel community website

In order to better reflect a lot of travel data and mine valuable information, this study selects mafengwo.com, a well-known domestic tourist community. This website has a large number of information and fast update speed. It is also set as a kind of target website for collecting experimental data. This study uses LocoySpide to collect data, and VisualC# to write the tool which can be operated in many systems such as XP. The tool can also collect information from all web pages.

4.1.2 Collation of collected data

The collected travel data need to be screened and analyzed. Statistics is conducted on the number of tourists and the number of photos in accordance with the research standards. For details, please refer to the table below. In addition, the corresponding tourist information is also sorted out and entered in the database. After sorting out, the specific screen shot is as follows:

Data collection table

	travel notes and photos	travel notes	photos	total
Number of people	1903/1/17	161	34	1208
Rate	85.09%	12.30%	2.59%	11%

User	Time	Figure	Number of days	Form	The per capita cost
Zipisuan(Beijing)	2016/10/18	man and wife	4	Leisure tour	2700
Linda(Shanghai)	2016/7/4	along	6	on foot	2500
Allen-King(Shanghai	2016/12/20	with friend	5	freewalker	5000
smallhorse	2017/1/11	along	2	Leisure	1000
KongNian	2016/2/2	along	5	Leisure	2500
BaYinhe(Dalian)	2016/7/23	with friend	5	Leisure	2000
Ziqiao(Xian)	2017/2/14	with friend	4	Leisure	3500
Jingxin (Zhengzhou)	2017/2/25	along	3	Leisure	
LvYou(Guangzhou)	2016/2/20	with children	5	Leisure	1500
eXiang(Beijing)	2017/2/9	along	5	Leisure	2000
vickyqin(Changsha)	2016/8/2	with children	3	self dirving	6000
ShengXiaomo(Zhejian	2016/8/9	with friend	12	DIY tour	4000
ChenFeng	2016/8/30	with friend	8	DIY tour	2300
Miaomi~	2017/2/23	man and wife	4	DIY tour	2000
DuoLaMi(DongGuan)	2017/2/1	with friend	3	Leisure	1300

Figure 5. A screenshot of the data collection situation table

4.2. Analysis of travel data

4.2.1. Statistical analysis of spatial-temporal distribution pattern of travel

Based on the screened information, this study analyzes the spatial-temporal distribution pattern, sets the number of tourists as the index, explores the corresponding time distribution characteristics of the inbound tourist flow in Xi'an, as well as makes statistics on the changes in the number of tourists, number of companions and stay with the change of month.

Along with the change in month, a total of 1,208 people is in accordance with the conditions, and the following is a corresponding histogram.

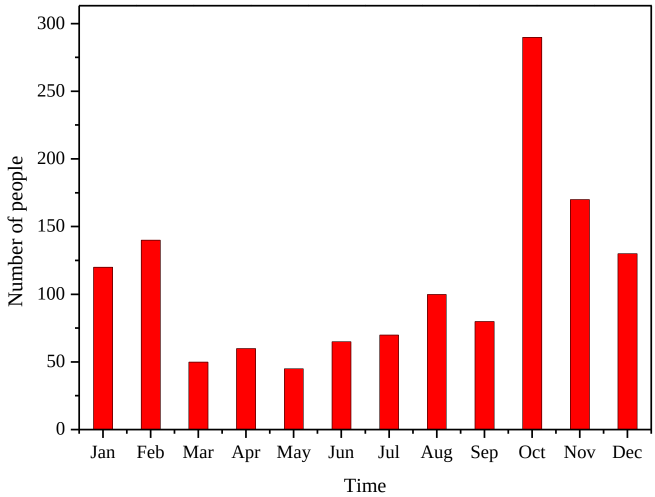

Figure 6. The diagram of tourist amount with different month

After the statistical analysis, it is found that the number of tourists to Xi'an during the National Day holiday is about 22.6% of that of the whole year. 2-4 people travel together and stay for about 3 days. Combined with the above results, it can be found that tourists presented in the collected data are mostly scattered tourists. According to the seasonality intensity index, it can be found that the local travel demand time is not evenly distributed. Therefore, based on the above target groups, this study explores the recommendation of travel services.

4.2.2. Analysis of core scenic spots based on social network travel flow

In the analysis, it is found that the local travel flow network nodes are not evenly distributed. Therefore, many travel nodes need to be connected in accordance with the core nodes. Six major nodes, including Terra-Cotta Warriors, Bell Tower and Huimin Street are taken as important nodes whose structural advantages are particularly prominent. They exist as a gathering point, hub and radiation point. It can be shown that tourists are mostly active at the central nodes and thus flow to other nodes. Therefore, based on the analysis of the core scenic spots, the city's scenic spots and attractions are recommended, and then non-central nodes and related scenic spots are recommended to tourists at the core scenic spots.

4.3. Construction of distributed Hadoop platform

4.3.1. Environmental preparation for construction

In order to carry out the experiment of the algorithm, this study sets up a cluster including nine hosts, one of which is set to be name node. The remaining is called datanode and all the configurations are identical. In the same local area network, their addresses and roles in the cluster are as follows:

Table 2. The name, IP, and use table of each node in the cluster

Hostname	IP address	Use
Master	10.2.192.47	Namenode, jobtracker
Slave1	10.2.192.48	Datanode, tasktracker
Slave2	10.2.192.49	Datanode, tasktracker
Slave3	10.2.192.50	Datanode, tasktracker
Slave4	10.2.192.51	Datanode, tasktracker
Slave5	10.2.192.52	Datanode, tasktracker
Slave6	10.2.192.53	Datanode, tasktracker
Slave7	10.2.192.54	Datanode, tasktracker
Slave8	10.2.192.55	Datanode, tasktracker

4.3.2. Installing and configuring jdk

In the Java official network, the jdk is downloaded and is decompressed and stored under the /usr/java directory. Then the environment variable is configured, the /etc/profile file is opened, and the environment variable is added to the file. In accordance with the configuration above, all machines in the cluster are configured, tested and installed. Java-version is input to terminal. If the installed version number is displayed, it indicates that jdk has been successfully installed.

4.3.3. Installing ssh and hadoop

When building hadoop cluster, it is necessary to rely on ssh to complete communication between different physical machines. Then ssh is downloaded and installed. When installing hadoop, /etc/hosts are needed to be installed on different devices. The hadoop is downloaded and the file is configured. After it passes the modification, it is verified that the cluster has been successfully built.

4.4. Parallelization experiment of MapReduceFP-Grownth algorithm

4.4.1. Experimental data

After the data analysis is completed, the data need to be further pre-processed. According to the analysis result of the network structure of the travel flow, a small part of the data appearing at the edge node can be eliminated, and then the travel data can be sorted out to form the corresponding transaction data. Semi-structuralized and un-structuralized data are transformed into data with a simple structure. All the processed transaction data express the main travel activities among the nodes of various scenic spots. There are many elements in the data, such as travel and food. After sorting this out, a number of transaction data are formed. The following is the corresponding screen shot. In this data, the meanings corresponding to different symbols are specifically shown in the screen shot.

4.4.2. Experimental result

Parallelization experiment of MapReduceFP-Grownth algorithm:

The sorted transaction data are uploaded to the file system, the instructions are executed and the edited MapReduce is packed. The result is shown below:

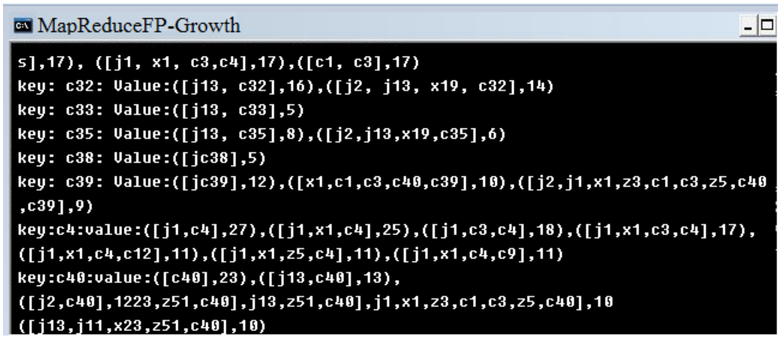

Figure 7. Operation result graph of Map Reduce FP-Growth

The minimum support number is set to avoid the low frequency. To ensure that the result is as comprehensive as possible, the minimum support number is set, and finally a number of association rules are formed. To avoid the occurrence of a lot of rules due to the high frequency, confidence coefficient is set for the program and is deleted in accordance with the following rules, after which a reduced association rule is formed. By screening, the following rules are formed in accordance with the Great Wild Goose Pagoda:

[j2]=>j13:confidence=0.397;

[j2,x19]=>j13:confidence=0.268;

[j11]=>j13:confidence=0.421;

[j11,x1]=>j13:confidence=0.327;

[j11,x1,z51]=>j13:confidence=0.219;

It is found that many elements of travel services, such as food and travel, are included in the rules. Although there are many repeated items, they still need to be merged. Tool is used to transfer the merged rule set into the relational database so that the corresponding travel service recommendation can be carried out.

5. Conclusions

(1) In the environment of Internet of Things, this study takes Hadoop as the base platform, collects, pre-processes and analyzes mass travel data so as to scientifically determine the recommendation strategies of scenic spots.

(2) The construction and configuration of the distributed cluster and relational data ETL tool Sqopde of the Hadoop platform is completed, ensuring that the program can operate well on the cluster.

(3) MapReduce programming method and operation mechanism are taken as the core algorithm and the classical FP-Growth data mining algorithm is parallelized to recommend travel information services.

(4) The experiment proves that the designed recommendation system has strong integration ability and the services provided by the system are more comprehensive and personalized so that the travel service platform becomes more humanized and the user’s experience is better.

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